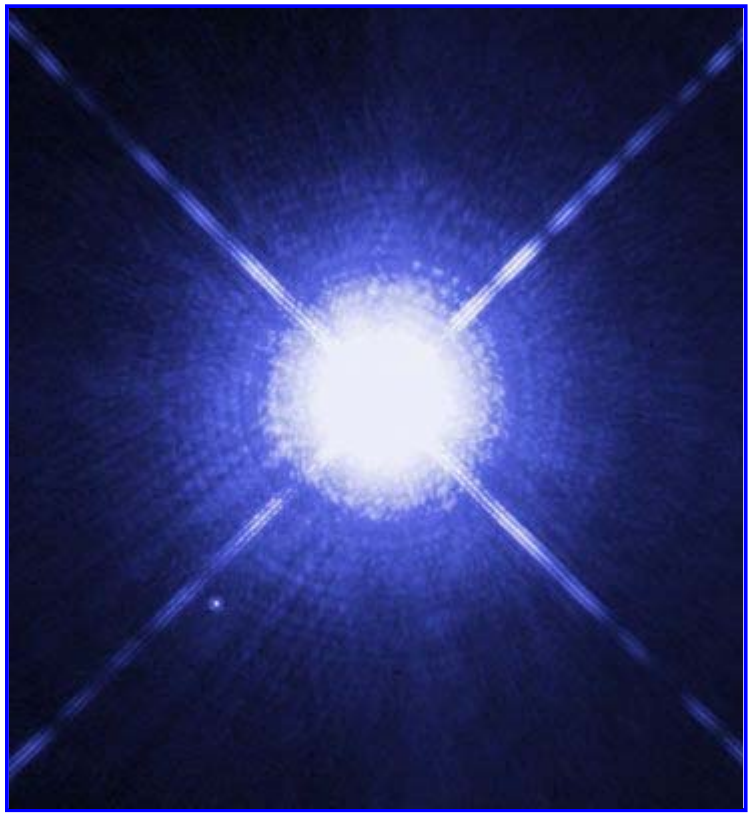
Sirius 2



H.E. Bond, E. Nelan, M. Burleigh, J.B. Holberg, STScI, NASA

Sirius A is hotter, bluer, and younger than our Sun, Sol. This Hubble image also shows white dwarf companion Sirius B, at lower left (more).

(See a Digitized Sky Survey image of Sirius from the Nearby Stars Database.)

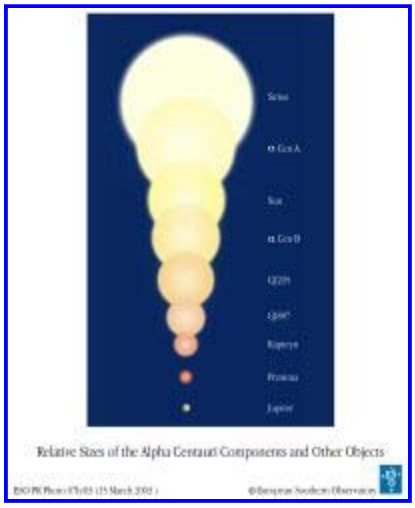
- **System Summary**

Also known as Alpha Canis Majoris, Sirius is the fifth closest system to Sol, at 8.6 light-years (ly) away. It is located in the north central part (06:45:08.92-16:42:58.02, ICRS 2000.0) of Constellation Canis Major, the Larger Dog. Sirius is also the lower left member of the "Winter Triangle" of first magnitude stars, whose other components are Procyon (Alpha Canis Minoris) at upper left and Betegeuse (Alpha Orionis) at right center. A binary, the system is the title member of the Sirius stellar moving group (also know as the Sirius Super Clusteror Ursa Major star stream), which include all five stars of the Great Dipper as well as Gemma and are mostly around 490 million years old and all moving towards the galactic center. Athough Ejnar Hertzsprung (1873-1967) claimed that Sirius was a likely member of the Ursa Major moving group as early as 1909, a 2003 study of possible moving group members using HIPPARCOS' parallax data led by Jeremy King was not able to confirm the system's membership (Ken Croswell, *Astronomy.com*, March 2005), and the Sirius system appears to be too young, only about half the apparent age of the Ursa Major star stream (Liebert et al, 2005; and Ken Croswell, 2005). (See Akira Fujii's color photo of Sirius -- at the top center of photo.)

McDonald Observatory -- larger image

Sirius is a binary star system.

Sirius is composed of a main-sequence star and a white dwarf stellar remnant. They form a close binary, Alpha Canis Majoris A and B, that is separated "on average" by only about 20 times the distance from the Earth to the Sun -- 19.8 astronomical units (AUs) of an orbital semi-major axis -- which is about the same as the distance between Uranus and our Sun ("Sol"). The companion star, is so dim that it cannot be perceived with the naked eye. After analyzing the motions of Sirius from 1833 to 1844, Friedrich Wilhelm Bessel (1784-1846) concluded that it had an unseen companion. However, Sirius B was not actually observed until January 31, 1862 by Alvan Graham Clark (1832-1897), who was testing a new 18-inch telescope built for Dearborn Observatory by the famous company founded by his father (Alvan Clark) and later run by his brother and himself. Clark was soon honored with the Lalande prize of the French Academy for his discovery. However, Star B's peculiar high temperature, small size, and great density were not established until 1925 by Walter Sydney Adams (1876-1956). (See an animation of the orbits of Stars A and B, and a possibly disrupted habitable zone around Star A, with a table of basic orbital and physical characteristics.)



VLTI, ESO

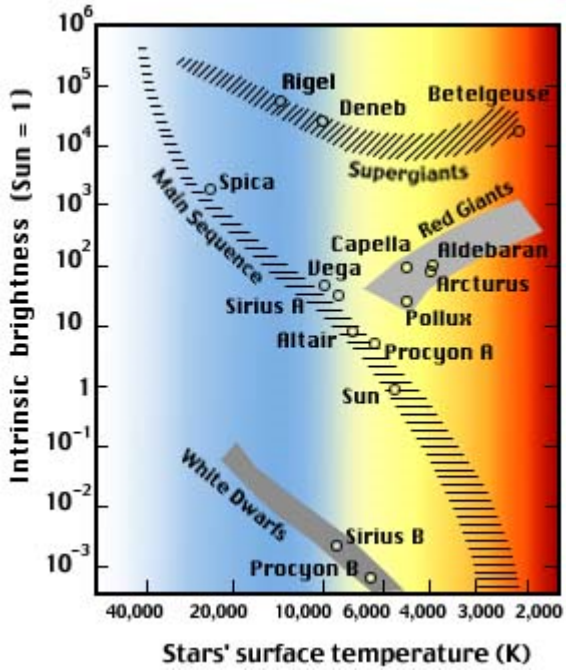
Larger and jumbo images.

Sirius A is substantially larger than Sol, although its white dwarf companion B is smaller than Jupiter (more from ESO).

Sirius A

Alpha Canis Majoris A, the Dog Star, is the brightest star in the night sky as well as the brightest star in its constellation. Unlike Sol, it is a slightly bluish, white main sequence dwarf star of spectral and luminosity type A0-1 Vm. This relatively large star has 2.02 (+/- 0.03, Liebert et al, 2005) to 2.14 times Sol's mass and about 1.68 to 1.71 (+/- 0.013) times its diameter (Kervalla et al, 2003; and Gatewood and Gatewood, 1978), but RECONS estimates a mass of 2.0 Solar based on luminosity. According to the Yale Bright Star Catalogue, 1991 5th

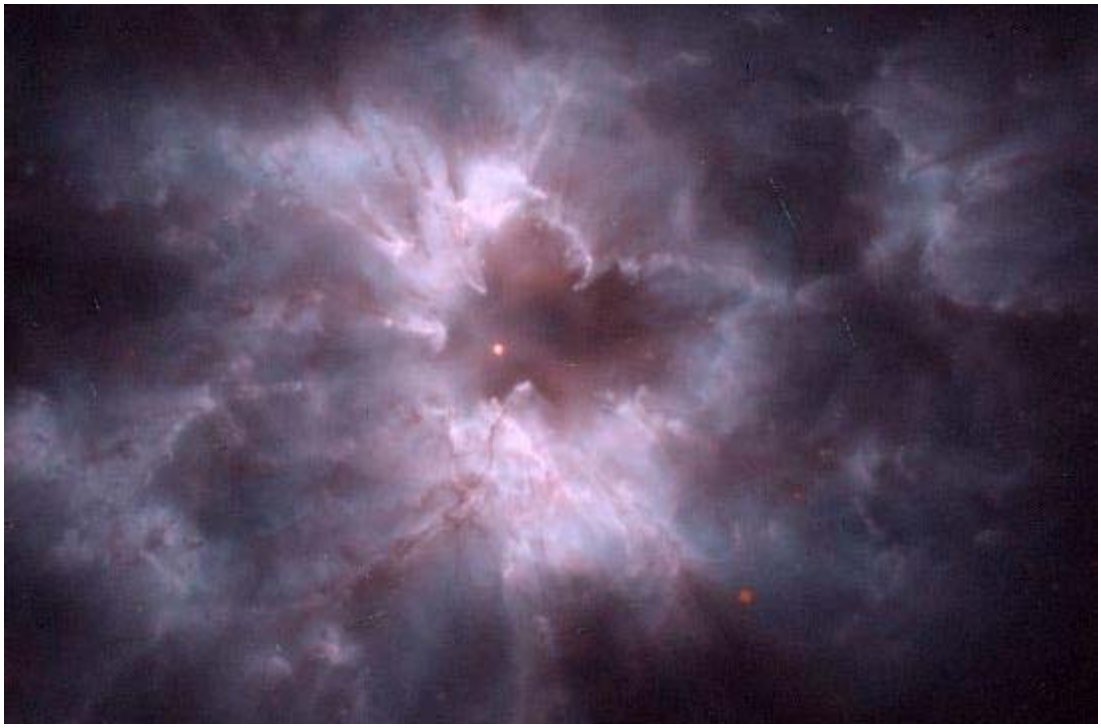
Revised Edition notes entry for HR 2491, diameter estimates vary from 0.00560 to 0.00589". Compared to Sol, Sirius A is hotter and more than 21 times brighter. It may be only about 225 to 250 million years old (Liebert et al, 2005; and Ken Croswell, 2005), but being so much bigger and hotter than Sol, the star will exhaust its core hydrogen within only a billion years and turn into a red giant or Cepheid variable before puffing away its outer layers to reveal a remnant core as a white dwarf.



NASA Observatorium

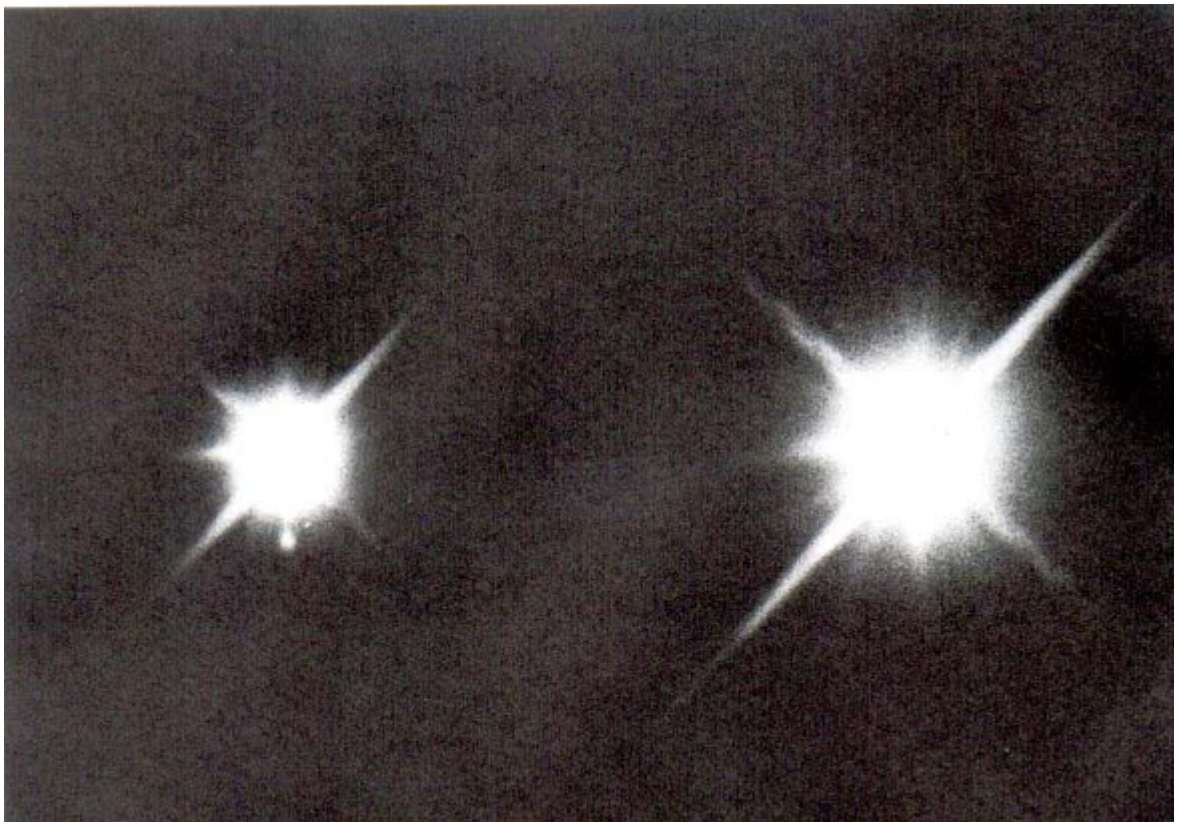
See a discussion of the "main sequence" as part of stellar evolution and death.

Dust has been detected in this binary system (Backman et al, 1986; and Kuchner and Brown, 2000 -- in postscript). Sirius A is rich in elements heavier than hydrogen ("metals rich"), as it has about one to 7.4 times the iron abundance of Sol (Cayrel de Strobel et al, 1991, pages 285-286). It was probably enriched by its companion star, which was once bigger and hotter than Sirius A and so evolved and "burnt out" even faster. Sirius B manufactured lots of heavier elements which it puffed out into space and onto Sirius A before becoming a white dwarf.



H. Bond (STSci), R. Ciardullo (PSU), WFPC2, HST, NASA
(Sirius B is a young white dwarf, a remnant stellar core, which enriched Sirius A with elements heavier than hydrogen when it cast off its outer gas layers, like planetary nebula NGC 2440)

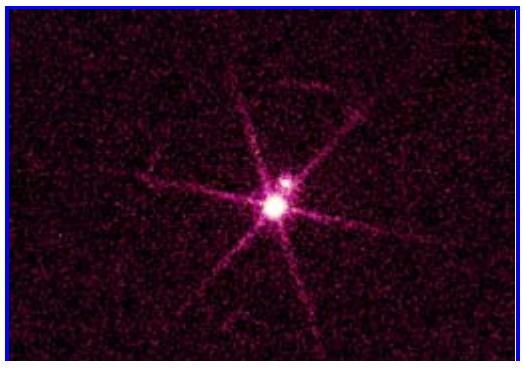
Sirius A is considered to be a variable star because its companion can boost its brightness when located in front of the star as observed from Earth. The distance separating Sirius A from its companion varies between 8.1 and 31.5 AUs as the two swing around in a highly eccentric orbit (e= 0.59) that takes 50.1 years to complete (Willem Henrik van den Bos, 1960; in the new Sixth Catalog of Visual Orbits of Binary Stars). (See an animation of the orbits of Stars A and B, and a possibly disrupted habitable zone around Star A, with a table of basic orbital and physical characteristics.) Useful star catalogue numbers and designations include: Alp or Alf CMa, 9 CMa, HR 2491, Gl 244 A, Hip 32349, HD 48915, BD-16 1591, SAO 151881, FK5 257, LHS 219, and ADS 5423 A.



Lick Observatory (Lick 3-m Telescope)

Short exposure on left reveals the faint white dwarf Sirius B, then located about 25 AUs below Sirius A, which is absent in the overexposed, longer exposure on right

The distance from Sirius A where an Earth-type planet would be comfortable with liquid water is about 4.6 AUs (at about the distance of Jupiter from the Sun in the Solar System), where its orbital period would be 6.8 years long. The orbit of any protoplanet forming around Sirius A at that distance could have been disrupted by the close orbit of Sirius B, and also probably during B's mass loss when it became a nova then a white dwarf. Even if it is possible for an Earth-type planet to orbit youthful Sirius A and develop life, it is likely to be primitive single-cell, anaerobic bacteria under constant bombardment by meteorites and comets as Earth was for the first billion years. Since there is unlikely to be free oxygen in the atmosphere of such a planet, it probably would not have an ozone layer (O_3) although Sirius A puts out a lot more hard radiation (especially ultraviolet) than Sol. (For an illustrated discussion, see Christoph Kulmann's web page on the unlikely habitable zone around Sirius A.)



NASA, CXC, and SAO

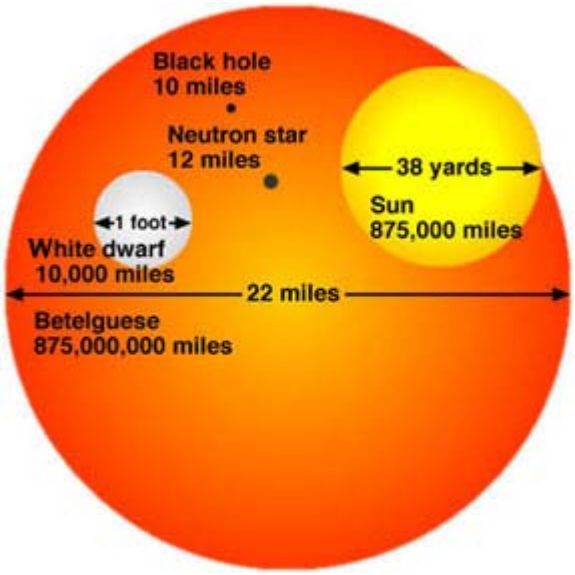
(larger x-ray image)

Sirius B is a much brighter source of x-rays than Sirius A. For more information, see the Chandra X-Ray Observatory's photo album and an

Astronomy Picture of the Day.

Sirius B

Nicknamed "the Pup" as the much smaller companion to the Dog Star, this much dimmer object is a white dwarf (DA2-5 or A2-5 VII). It is more than 8,200 times fainter than Sirius A and 360 times fainter than Sol. Compared with our Sun, it appears to have the same mass (97.8 to 103.4 percent, Hubble press release; Barstow et al, 2005; Liebert et al, 2005; and Holberg et al, 1998) but less than one percent (0.0864 +/- 0.012) of its diameter (Barstow et al, 2005; and Holberg et al, 1998). In fact, Sirius B's diameter of about 11,700 km (about 7,300 miles) is about 92 percent of Earth's. Its mass and diameter are consistent with the theoretical size for a carbon-core white dwarf, one that may have evolved from a 5.05 +0.374/-0.276 Solar-mass, B-type main-sequence star about 124 +/- 5 million years ago, after 101 to 126 million years as a giant star (Liebert et al, 2005; and Ken Croswell, 2005). Hence, Sirius B was once brighter than Regulus A, currently a B7 main-sequence star. While now tiny compared to main sequence stars, white dwarf stars are actually intensely hot, but without the internal heat of fusion to keep them burning, they gradually cool and fade away.



NASA Observatorium

See a discussion of "stellar remnants" as part of stellar evolution and death.

Sirius B was the first White Dwarf to be discovered, but it took almost a century from its discovery to the wide acceptance of its nature as a stellar remnant. The star's calculated average density is 92,000 times that of Sol's, so that one cubic inch of its material would weigh about 15 tons at the surface of the Earth. Useful catalogue numbers include Gl 244 B and ADS 5423 B.

Hunt for Sirius C and Substellar Companions

According to Duchner and Brown (2000 preprint -- in postscript), three analyses of the proper motion of Sirius found a perturbation in the orbit of Sirius B with a period around six years (Ch.

Volet, 1932; Walbaum and Duvent, 1983; and Benest and Duvent, 1995). The analyses did not resolve whether the perturbing body orbits Sirius A or B, although dynamical simulations suggest that stable orbits exist around both stars at circumstellar distances up to more than half the binary system's closest separation of 8.1 AUs (Daniel Benest, 1989). Because ancient astronomers believed that Sirius was red in color as late as 2,000 years ago, some investigators wonder if the system may have a third stellar component, Sirius C, with about five percent of Sol's mass that implies a spectral type M5-9 in a six-year elliptical orbit around Sirius A (Benest and Duvent, 1995). A recent search for faint companions using the Hubble Space Telescope found no supporting evidence for a large Jupiter or brown dwarf sized object, although the observed positions of Sirius AB -- Gl 244 AB -- differed from published orbital elements (Schroeder et al, 2000).

- **Closest Neighbors**

  The following star systems are located within 10 light-years of Sirius AB.

Star System	Spectra & Luminosity	Distance (light-years)
Procyon AB	F5 V-IV DA-F/VII	5.2
Luyten's Star	M3.5-5 Ve	5.8
Ross 614 AB	M4.5 Ve ?	5.5
Kapteyn's Star	M0-1.5 VI	7.5
Epsilon Eridani	K2 V	7.8
Sol	G2 V	8.6
LHS 1565	M5.5 V	8.9
Wolf 359	M5.8 Ve	9.0
DX Cancri	M6.5 Ve	9.2
Proxima Centauri	M5.5 Ve	9.3
Alpha Centauri AB	G2 V K0 V	9.5
LTT 12352	M3.5 V	9.9

- **Other Information**

  - Try Professor Jim Kaler's Stars site for other information about Sirius at the University of Illinois' Department of Astronomy. For another illustrated discussion, see Christoph Kulmann's web page on the unlikely habitable zone around Sirius A.

  - Up-to-date technical summaries on these stars can be found at: the Astronomiches Rechen-Institute at Heidelberg's ARICNS pages for Star A and Star B, the Nearby Stars Database, and the Research Consortium on Nearby Stars (RECONS) list of the 100 Nearest Star Systems. Additional information may be available at Roger Wilcox's Internet

Stellar Database.

- "Sirius" is Greek for "The Sparkling or Scorching One," whose adjectives were once applied to all stars of which this was the brightest example. It is not visible in the night sky during the Summer, and so the Greeks thought that Sirius added its heat to that of the sun, producing the hot summer months. Indeed, we still refer to the hottest days of Summer as "dog days," which is fitting for the "Dog Star." Outside of Summer, it is best viewed in the Northern Hemisphere from January through March as the brightest star of Constellation Canis Major. For more information about the stars and objects in this constellation and an illustration, go to Christine Kronberg's Canis Major. For another illustration, see David Haworth's Canis Major.

- For more information about stars including spectral and luminosity class codes, go to ChView's webpage on The Stars of the Milky Way.